



Wideband Instrument for Snow Measurements (WISM)

Presenter:

Dr. Félix A. Miranda

Acting Deputy Chief, Communications and Intelligent Systems Division
NASA Glenn Research Center
Cleveland, OH 44135

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This effort is being performed under the following NASA funded work

**“Enhancement, Demonstration, and Validation of the
Wideband Instrument for Snow Measurements (WISM)”**

**NASA Research Opportunities in Space and Earth Sciences
(ROSES) 2013 Instrument Incubator Program (IIP)
Cooperative Agreement # NNX14AI04A
Dr. Tim Durham, PI**

Importance of Snow

- 50% to 80% of the yearly water supply in the western United States is supplied by the seasonal snowpack.
- To effectively manage water resources, accurate measurement of the amount of water in the snowpack, the snow water equivalent (SWE), is needed on the very small spatial scales over which the snowpack varies.



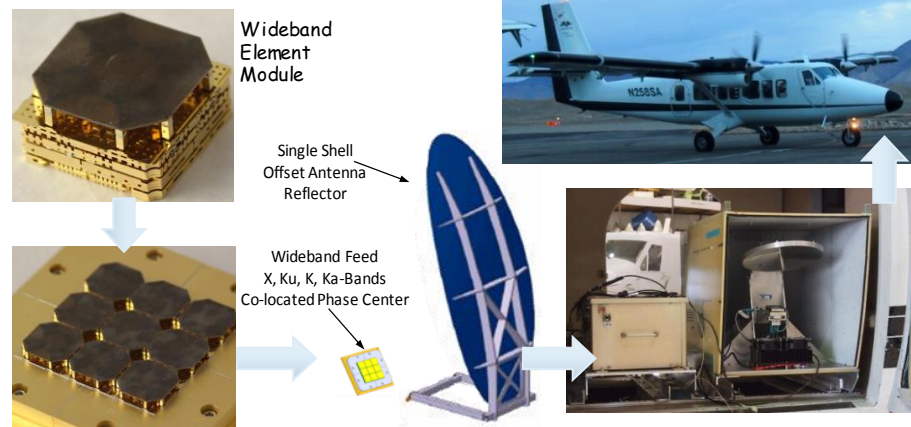
Highly variable snowpack

Enhancement, Validation, and Demonstration of the Wideband Instrument for Snow Measurements (WISM)

PT: Tim Durham Harris Corporation

Objective

- Advance the utility of a wideband active and passive instrument (8-40 GHz) to support the snow science community
- Improve snow measurements through advanced calibration and expanded frequency of active and passive sensors
- Demonstrate science utility through airborne retrievals of snow water equivalent (SWE)
- Advance the technology readiness of broadband current sheet array (CSA) antenna technology for spaceflight applications



Enabled by advanced CSA technology, WISM is a new broadband multi-function research instrument for NASA's snow remote sensing community

Approach

- Calibrate CSA using noise injection
- Use ground-based corner reflectors for radar calibration
- Add X-band radiometer and Ku-band SAR to instrument
- Conduct three flight campaigns including a mapping airborne lidar and extensive ground measurements to validate retrievals
- Optimize design of CSA for improved loss, beam/aperture efficiency, and scalability

CoIs/Partners: Kerry Speed, Robert Lange, Art Olsen, Brett Smith, Robert Taylor, Mark Schmidt, Harris Corp; Leung Tsang, Shurun Tan, Univ. of Michigan; Paul Racette, Quenton Bonds, Ludovic Brucker, GSFC; Lora Koenig, University of Colorado; Félix Miranda, GRC; Kevin Lambert (GRC/Vantage Partners, LLC); Hans-Peter Marshall, Boise State Univ.; Ken Vanhille, Anatoly Borissenko, Nuvotronics

Key Milestones

- Add wideband noise injection calibration system to radiometer 11/14 08/15
- Conduct engineering flight campaign 01/15 01/15
- Add an additional frequency (13.6 GHz) to radar 08/15 01/16
- Conduct 1st science flight campaign (dry land) 10/15 10/15
- Conduct 2nd science flight campaign (snow) 04/16 02/17
- Complete design and build of 2nd generation CSA 10/16 10/16
- Complete data analysis and generate science data products 12/16 05/17

TRL_{in} = 4

TRL_{current} = 4

ESTO
Earth Science Technology Office



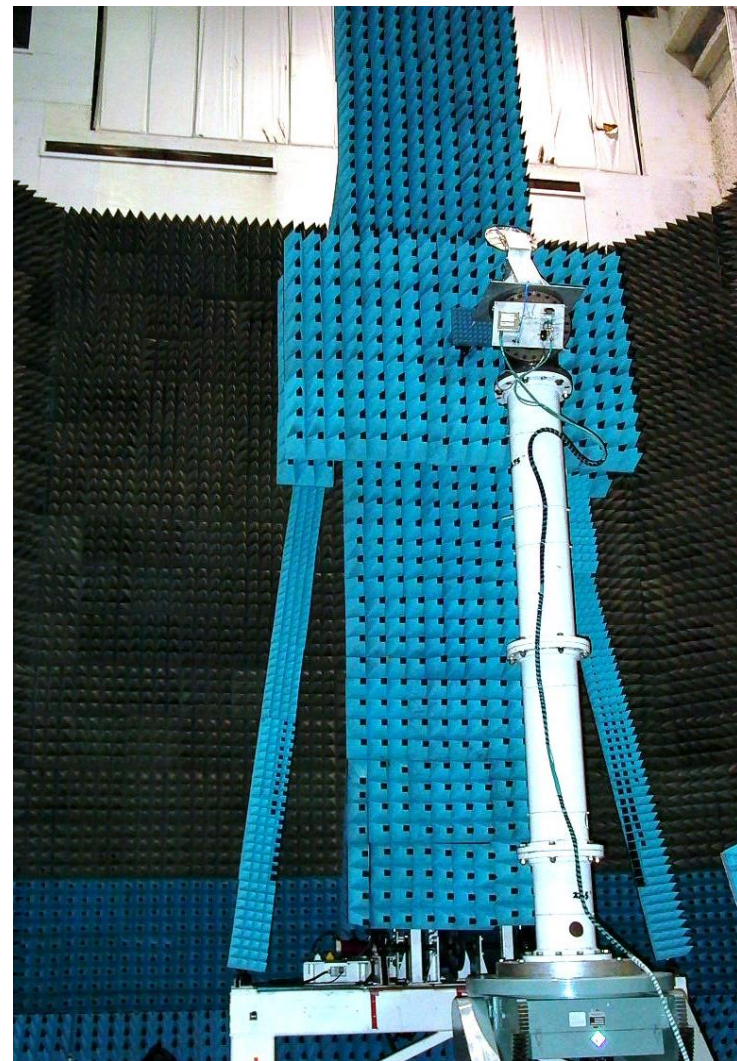
Wideband Instrument Development

- A major part of this IIP effort is putting together an instrument consisting of a radar and radiometer operating at multiple frequencies
- The goals of this instrument development are:
 - Demonstrate the use of a single wideband aperture for SWE retrieval
 - Provide data to support development of wideband SWE extraction techniques
 - Design an instrument useful to support future Snow and Cold Land Processes (SCLP) related science campaigns

WISM Secondary Antenna Measurements

NASA GRC Planar Near-Field Range

- 40' x 40' x 60' test volume
- Vertical Scanner with 22' x 22' scan plane
- 15 ton capacity azimuth over elevation pedestal
- Removable sidewall, bridge cranes and drive in dock
- Nearfield Systems, Inc., transceiver, motion control, experiment and data processing software
- Transceiver frequency range 2-50 GHz
- Probe rotational stage for automated polarization control



WISM Secondary Antenna Measurements

Reflector Surface Characterization, Feed Integration and Alignment

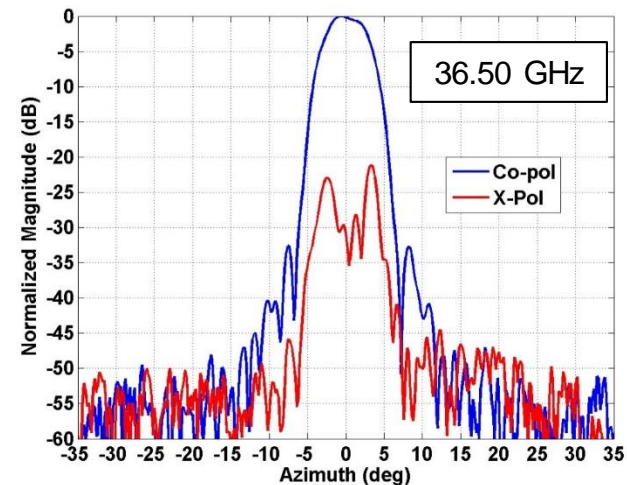
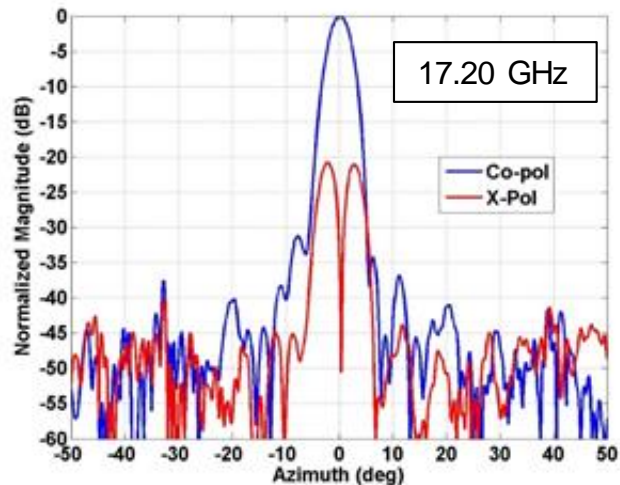
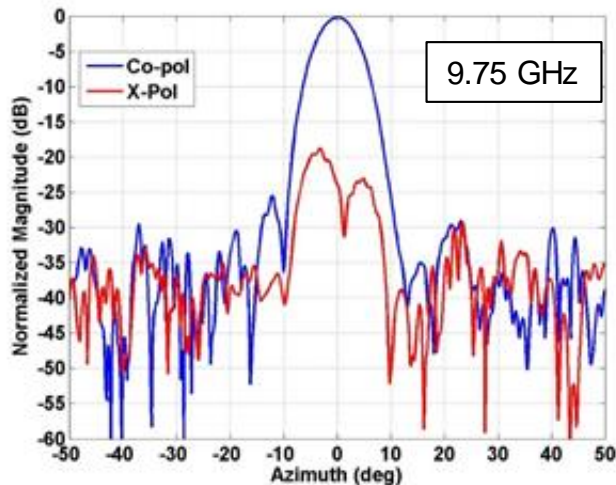
- Leica Geosystems, LR200 Laser Radar
- Surface mapping and data analysis
 - Provides equivalent paraboloid
 - Focal point location
- Feed integration
 - Feed phase center known from design and RF measurement
 - Feed position mapped relative to reflector surface
- Feed alignment
 - Iterative process spanning Sept. 9-24, 2014
 - IGES models from laser measurements submitted to Harris
 - Analysis and discussion produces recommended adjustment
 - Final position: phase center 0.013 inch from focal point (0.044λ at 40 GHz)



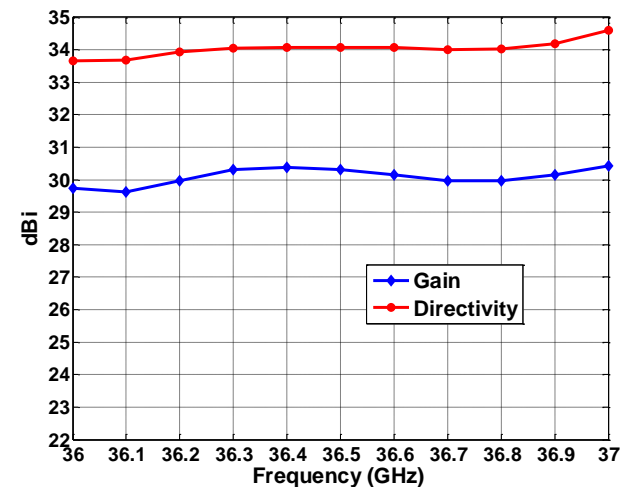
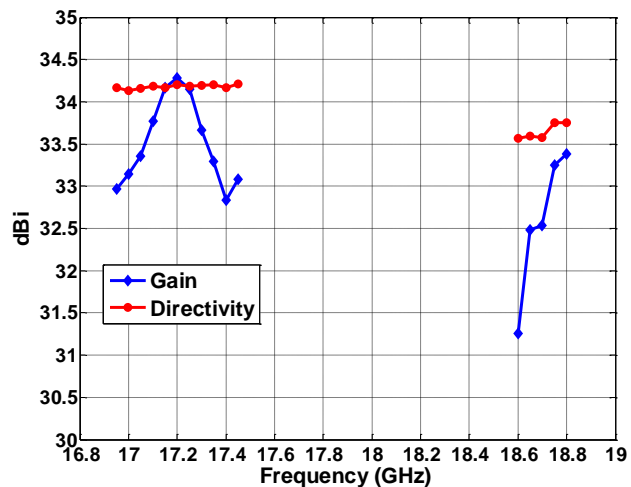
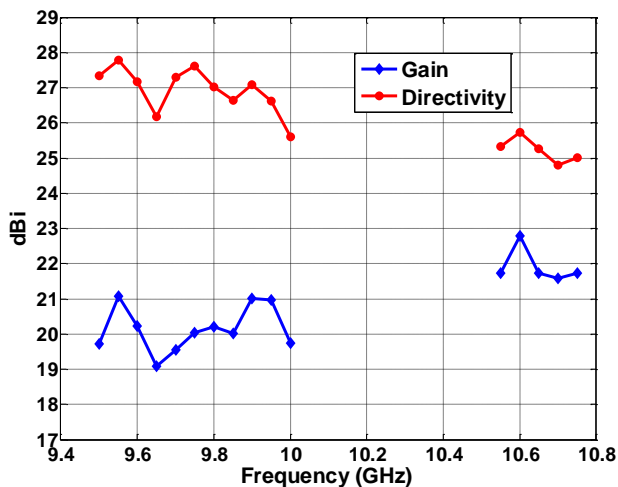


WISM Secondary Antenna Measurements

Patterns:



Directivity and Gain:





Overview of Planned Work

- Wideband antenna
 - Complete trades required for enhanced antenna design
 - Goal is to improve all major parameters of interest (i.e. match, beam efficiency, loss)
 - Fabricate prototypes and two final build antennas
- Airborne Instrument Design
 - Radar
 - Complete Synthetic Aperture Radar (SAR) data processing
 - Add a third frequency to radar between current bands
 - Process second (dry land) air campaign data and pass to science team
 - Radiometer
 - Complete data processing development
 - Process second air campaign data and pass to science team
- Ground SWE Experiments
 - Process data from the second air campaign
 - Continue ground based experiments at Boise State University
- Airborne Experiments
 - Complete preparations for next snow campaign
 - Carry out third (snow) campaign in Feb 2016